



---

# ECLOUD STUDIES AT TEVATRON

Xiaolong Zhang, Bruce Hanna

FNAL, AD/Tevatron

*Tevatron Accelerator Studies Workshop*





# Effects of Electron Cloud



- Vacuum instabilities:
  - Fast vacuum jumps of several order of magnitude
- Beam instabilities
- Beam losses
- Heat loading
- Noise on beam instruments



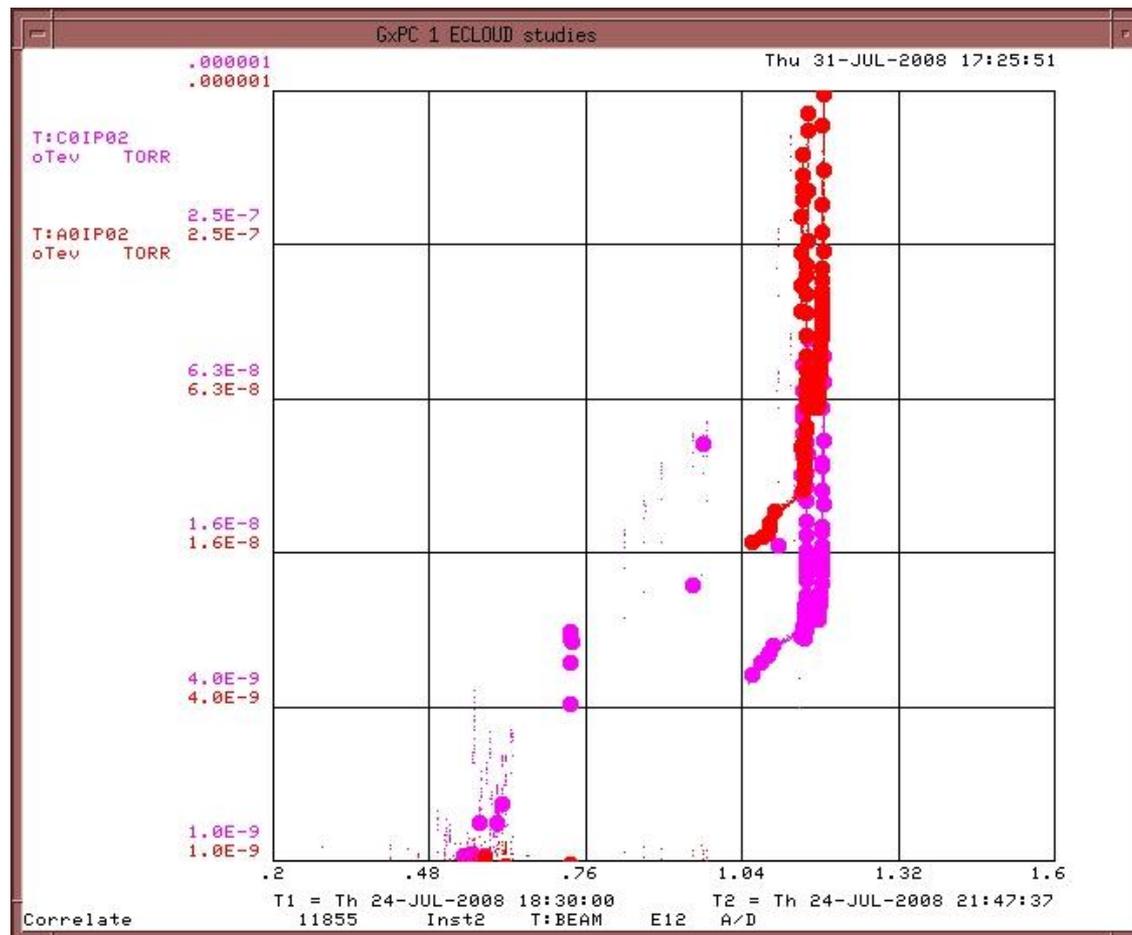
# Studies at Tevatron



- Started from Dec. 2002, not a problem for Tevatron.
- Intensive studies carried out since May, 2005 when proton driver and MI upgrade purposed.
- Objectives:
  - Benchmark the simulation code;
  - Measure the electron cloud and energy distribution (since beam is stored in Tevatron while MI in constantly cycling);
  - Studies if Tevatron run as 800GeV fix target or 150GeV stretcher ring;
- Observation:
  - Vacuum jumps (especially in MI-type magnets);
  - Emittance growth;
  - Threshold of  $2\sim 4e10$ /bunch for a 30-bunch train;
  - Varies with orbit (maybe the wakefield effect);



# Vacuum vs. IBEAM



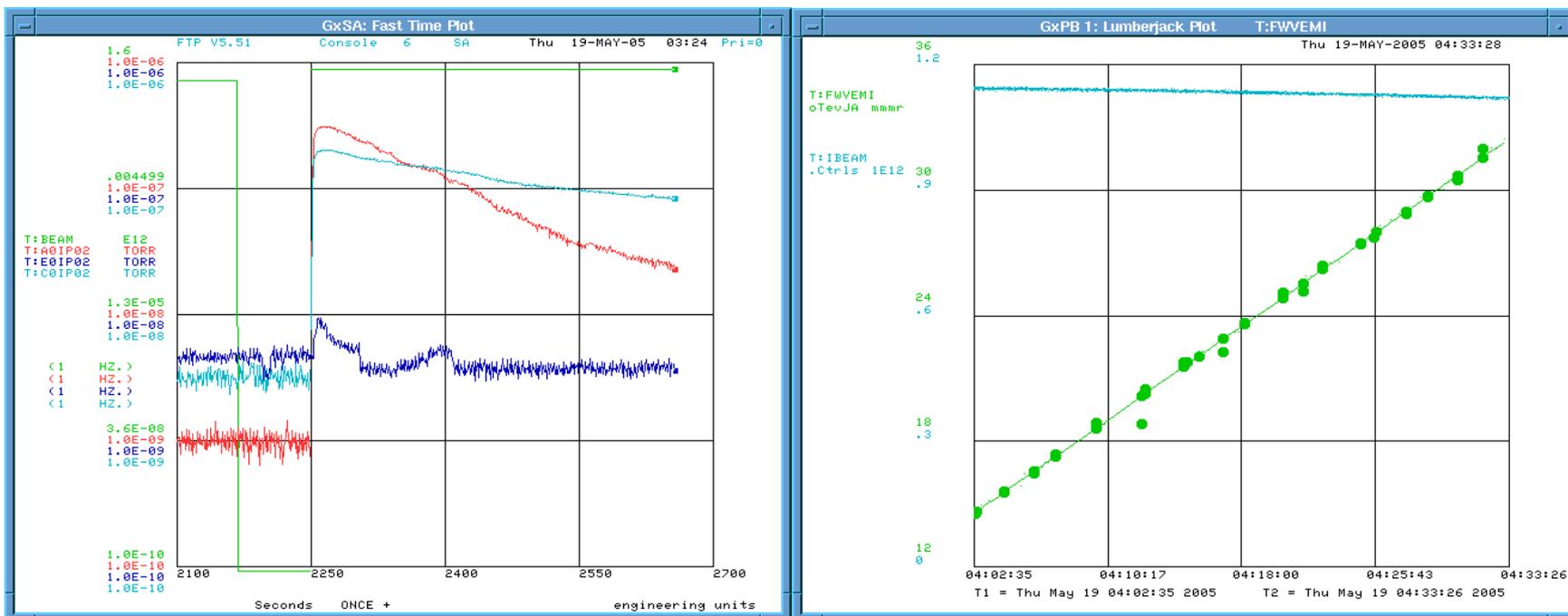


# Observations



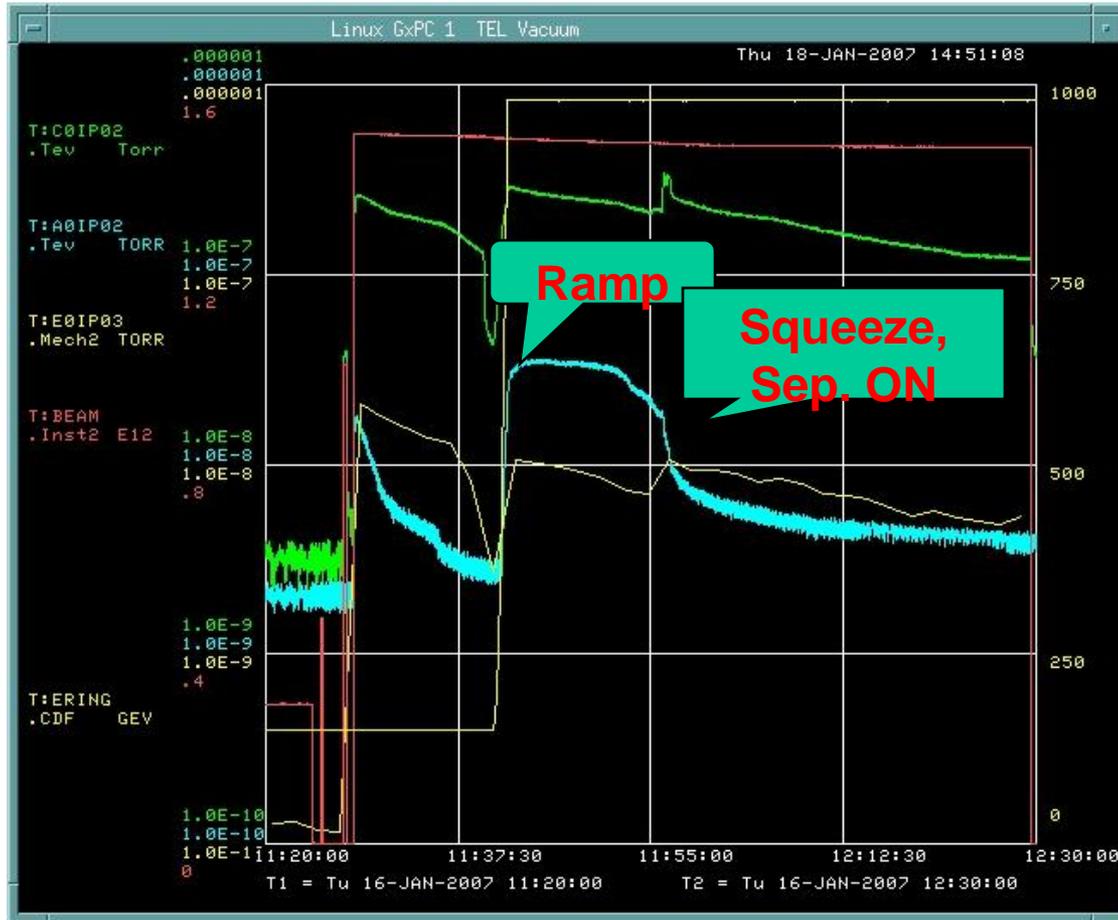
Tevatron 150GeV, 116e10/30bunches

**Beam lifetime 24.4hrs**  
**Emittance growth  $34.8\pi/hr$**





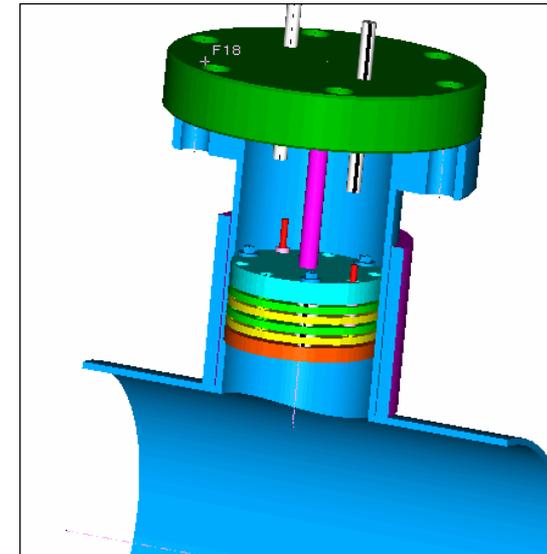
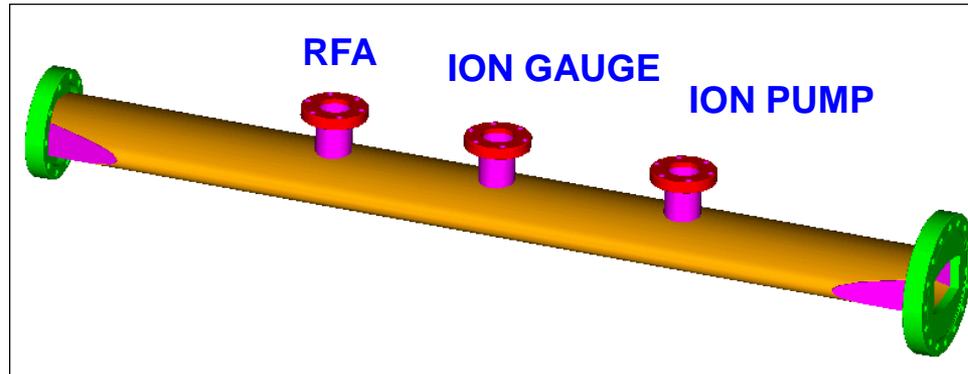
# Vacuum Pressure Rise



Jan. 16, 2007

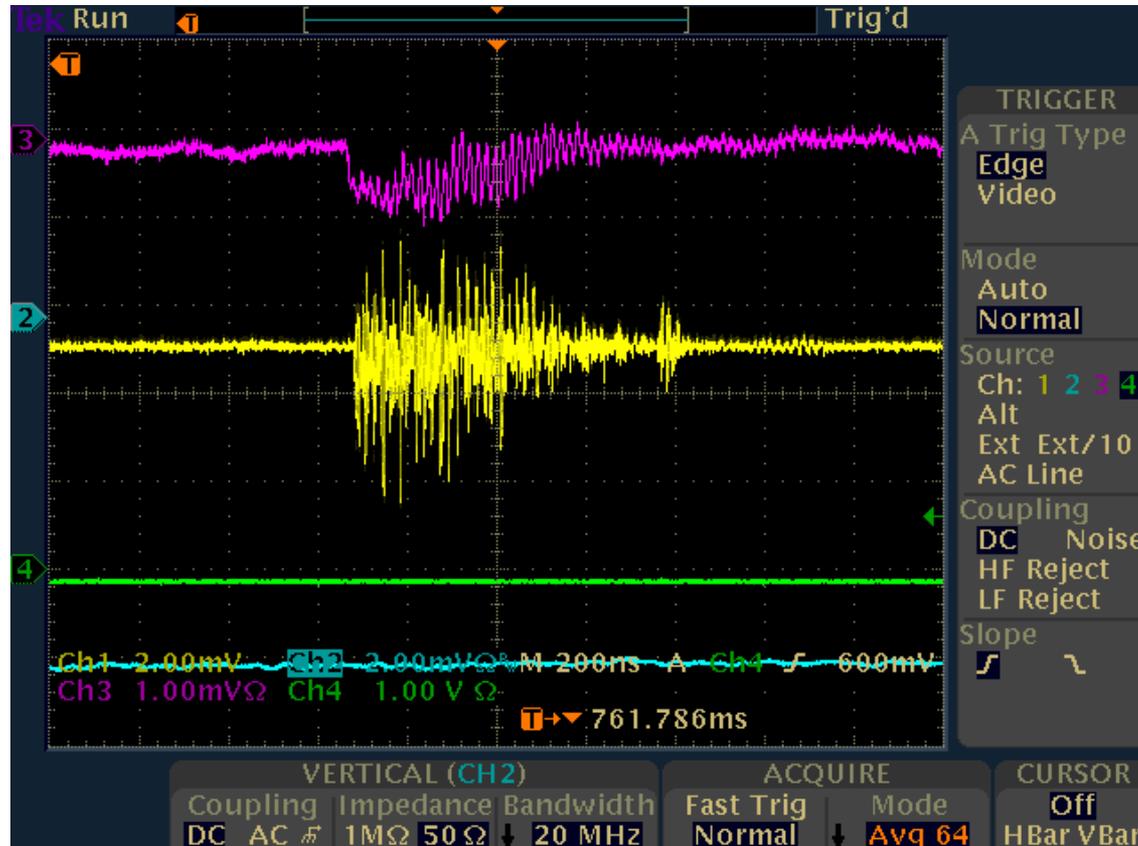


# RFA Testing Beam Pipe in Tevatron and MI





# RFA signal





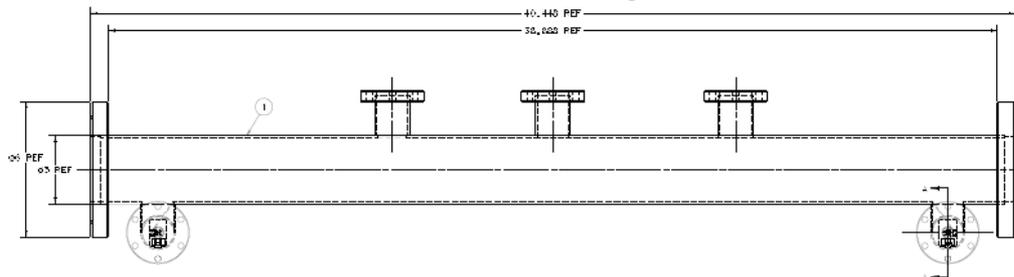
# Instrumentations



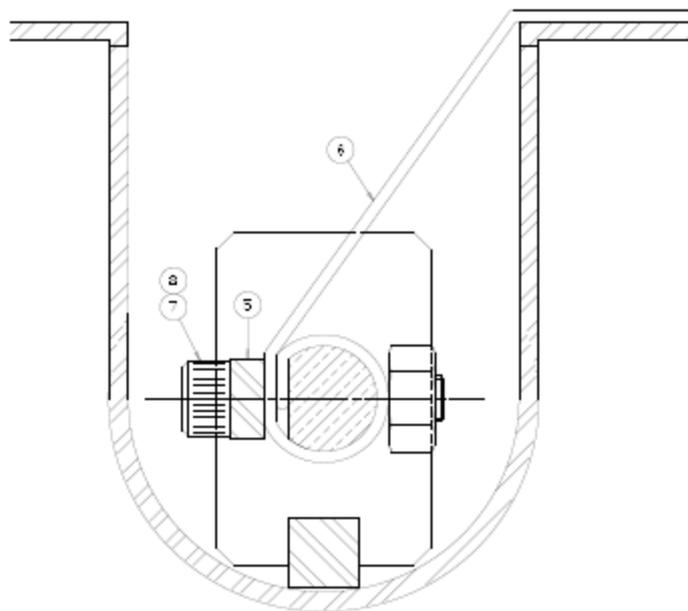
- Installed @Tevatron:
  - Argonne RFA on MI type vacuum chamber;
  - No amplification;
  - Long cable;
  - Bunch beam signal dominates;
- New improved RFAs were designed and made at Fermilab with higher efficiency include amplifier on detector;
- New cables needed;
- Need develop bunch by bunch tune, emittance and position measurements;
- E-CLOUD measurements using microwave (which is done successfully at MI but not fully understand, probably can be tested using TEL);



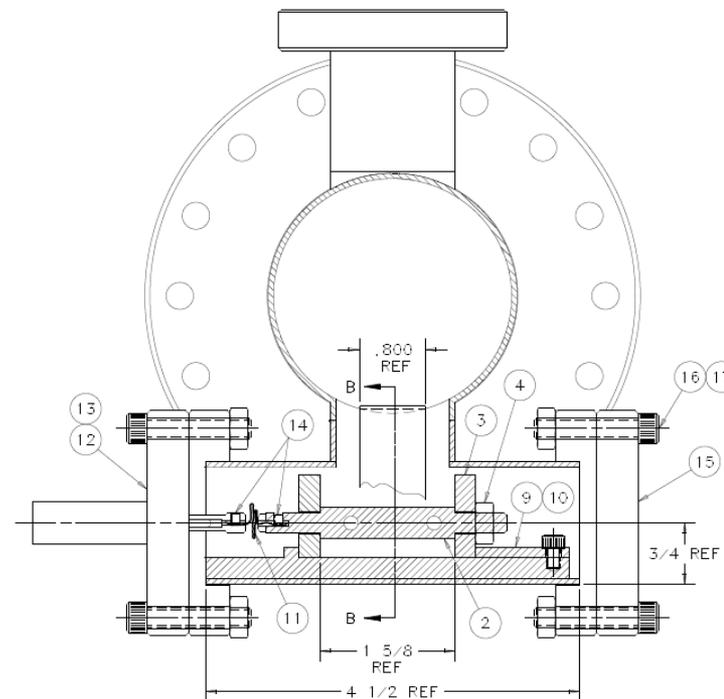
# Preliminary Design



Kapton Insulation  
S.S. strip w. or w/o NEG coating



VIEW B-B  
SCALE 4:1



SECTION A-A  
SCALE FULL



# Clearing Electrode

---



- Pros:
  - Can suppress Ecloud efficiently;
  - Easy to install in magnets than the coating;
  - No beam scrubbing time needed;
  - Can be used as to improve vacuum (like Tevatron SNEG);
  - Can measure Ecloud density in magnets;
  - Cross check with microwave measurements;
- Cons:
  - Impedance ?
  - Longevities?



# Injection of more bunches



- Successfully injected 50 bunches without changes made to Tevatron; possibly 80 bunches could be injected.
- But the bunch intensity limited by linac.
- Maybe the slip stacked Mi beam can be injected in the future.



---

*Your valuable inputs are appreciated!*

**THANKS!**